

PERITONEAL ADHESIONS AND THEIR RELATION TO ABDOMINAL SURGERY

LES ADHERENCES PERITONEALES ET LEURS RAPPORTS AVEC LA CHIRURGIE ABDOMINALE

THESE

présentée à la Faculté de médecine de l'Université de Genève
pour obtenir le grade de docteur en médecine

par

Marc-André WEIBEL

de

GENEVE et GROSSAFFOLTERN (Berne)

Thèse No 3338

GENEVE

Editions Médecine et Hygiène

1974



Digitized by the Internet Archive
in 2026

https://archive.org/details/IA41545931_0055

PERITONEAL ADHESIONS AND THEIR RELATION TO ABDOMINAL SURGERY

LES ADHERENCES PERITONEALES ET LEURS RAPPORTS AVEC LA CHIRURGIE ABDOMINALE

THESE

présentée à la Faculté de médecine de l'Université de Genève
pour obtenir le grade de docteur en médecine

par

Marc-André WEIBEL

de

GENEVE et GROSSAFFOLTERN (Berne)

Thèse No 3338

GENEVE

Editions Médecine et Hygiène

1974

La Faculté de médecine, sur le préavis du professeur Guido Majno, autorise l'impression de la présente thèse, sans prétendre par là émettre d'opinion sur les propositions qui y sont énoncées.

Genève, le 12 avril 1973

Le doyen :
William Geisendorf

Thèse No 3338



Je tiens à exprimer ma vive reconnaissance au professeur Guido Majno qui, particulièrement intéressé aux phénomènes de l'inflammation et de la cicatrisation des plaies, m'a suggéré le sujet de cette thèse et l'a guidée avec beaucoup d'attention.

Mes remerciements s'adressent également à Monsieur Willi Berchtold pour ses précieux conseils en matière de statistique.

A SABINE

Peritoneal Adhesions and Their Relation to Abdominal Surgery

A Postmortem Study

M.-A. Weibel, MD, Geneva, Switzerland

G. Majno, MD, Geneva, Switzerland

Despite the vast amount of literature on adhesions, few attempts have been made to study the statistical aspects of abdominal adhesions in particular. Of the seven reports that we could find, most are based on surgical observations made at repeated laparotomy [1-4]. One is a study of cases by radiography with pneumoperitoneum [5], and two are postmortem studies [6,7]. Our own investigation is based on autopsy findings; we chose this approach because it is the only one that affords complete and wholly reliable exploration of the peritoneal cavity and in order to provide data on the following points: (1) the frequency and distribution of abdominal adhesions, both spontaneous and postoperative; (2) the relation between given types of abdominal surgery and the ensuing adhesions; (3) the role of age, sex, and ascites; (4) the constitutional factor; several authors have stated that men with an "asthenic" constitution according to Stiller's classification were especially prone to the development of adhesions [1,2,6,8,9]; (5) the histologic features of adhesions as an aid to understanding their pathogenesis.

We have appended to this study a short, critical list of those means of prevention that seem most promising.

From the Departments of Surgery and Pathology, University of Geneva, Geneva, Switzerland.

Reprint requests should be addressed to Dr Majno, Department of Pathology, 40 bd. de la Cluse, CH-1205 Geneva, Switzerland.

Material and Methods

Between April 13 and December 31, 1970, 522 women, 597 men, and 110 infants and children below the age of ten died at the Hôpital Cantonal of Geneva. Of the adults, autopsies were performed on 752 subjects (67.2 per cent), that is, 336 women and 416 men. Abdominal adhesions were studied in all these cases. A special protocol was drawn up, with a checklist including topography of adhesions, surgical history, and the presence of peritonitis, tumor, or ascites.

By *adhesions* we mean both the viscerovisceral and visceroparietal types; by *spontaneous adhesions* we mean those that are not preceded by a surgical procedure and, thus, presumably caused, in most cases, by an inflammatory process [9-21]. Adhesions caused by a neoplastic process were excluded (except in Figure 1) because their pathogenesis is peculiar and not directly comparable to that of the group as a whole. However, spontaneous adhesions were included in the study. For histologic study, one to three samples were taken from 105 adhesions chosen at random; fifty-five of these cases had prior surgery. The tissues were embedded in paraffin, cut at 5 μ , and stained with hematoxylin and eosin, Mallory trichrome, Mallory fibrin, and Prussian blue methods. The sections were also studied under polarized light.

We used the chi square test for binomial distributions (that is, to compare the percentage of adhesions in different groups) and the t test for Student distributions (that is, to compare body weights or heights).

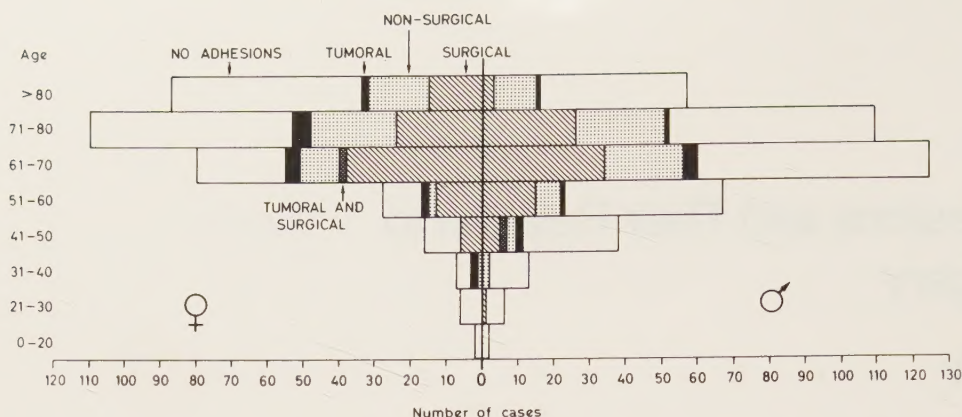


Figure 1. Age and sex distribution of all cases.

Results

Results are summarized in Figures 1 to 10.

Figure 1 gives the age and sex distribution of all the cases studied. The white part of the bars represents cases without adhesions. Children below the age of ten were not included. Neoplastic adhesions are recorded in this figure only. Most of these cases of neoplastic adhesions were found in patients without prior surgery (except four women and two men who had been operated on for abdominal tumors; in these patients the adhesions may have been neoplastic as well as inflammatory).

Figure 2 shows the incidence of adhesions with or without abdominal surgery. This scheme shows that in more than one quarter of patients without prior surgery, peritoneal adhesions existed anyway; in the patients with surgery, the incidence rose to 65 to 69 per cent. With or without operation, adhesions were a little more frequent in women, but the difference was not statistically significant.

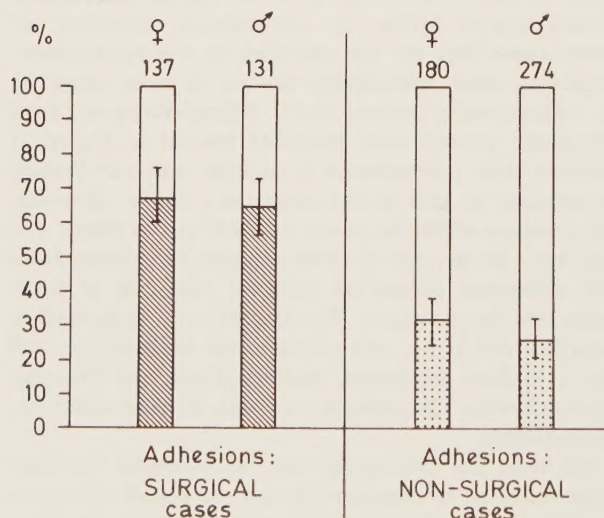


Figure 2. Incidence of adhesions with and without abdominal surgery.

Figure 3 gives the age distribution of patients (surgical and nonsurgical) with adhesions. The age groups are the same as in Figure 1. Statistical study showed that the chances of developing post-operative adhesions were the same at all ages, that is, there was no significant difference in incidence among patients of different ages with surgery. However, there was a highly significant increase of spontaneous adhesions beginning at age sixty-one; before that age the percentage of spontaneous adhesions seems to be fairly constant, as far as may be judged from the relatively small number of cases. The decrease after age eighty is not significant. (Table I.)

Figure 4 shows the relation between the percentage of adhesions and type of surgery. The minor operations included appendectomy (adhesions were found in forty of eighty-five cases), exploratory laparotomy (six of ten), gastroenteroanastomosis (three of eight), suture for ulcer disease (three of three), and a few other operations (seven of ten). The major operations included gastrectomy (fourteen of twenty-one), aortic or aortoiliac bypass (nine of twelve), colectomy and amputation of the rectum (ten of eleven), cholecystectomy, (eight of eleven), and various operations (twelve of thirteen), two of which were for releasing adhesions. Of the forty-five patients with multiple operations, adhesions were found in forty-two, as shown in Table II.

Table II shows that most of the minor operations were appendectomies (twenty-one) and palliative gastrojejunostomies (five). Of the major operations, there were seventeen gastrectomies, seventeen operations on the colon and sigmoid, ten cholecystectomies, eight resections of small intestine, and three operations for freeing adhesions. The three cases in which adhesions did not develop despite multiple operations had the same history: appendectomy many years previously, fol-

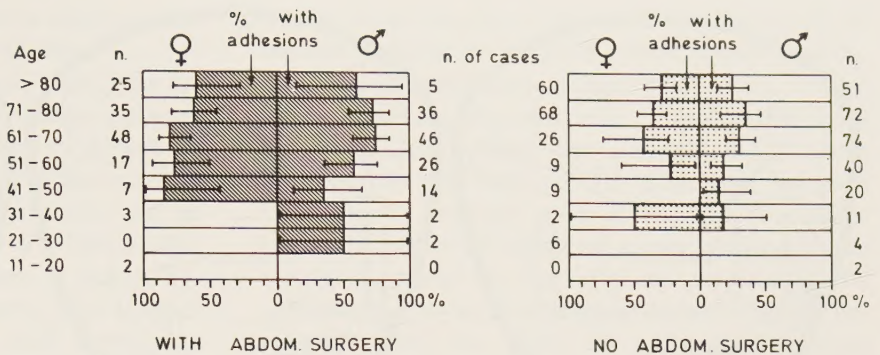


Figure 3. Age distribution of adhesions (surgical and nonsurgical).

lowed by either surgery of the gallbladder or stomach or laparoscopy (twelve, ninety, and sixty days prior to death). Gynecologic operations were distributed as follows: total hysterectomy with ovariectomy (seventeen of seventeen), subtotal hysterectomy and myomectomy (two of ten), and removal of the tube and ovary alone or tubal ligation (six of eight).

Figures 5 to 10 show the topography of adhesions after different types of surgical procedures. On these schemes each line corresponds to one adhesion, whether recent or old, fibrous band or full-face adhesion. A vertical line crossing the small intestine indicates multiple adhesions between the loops. The width of each line is proportional to the frequency of a given location; the figure next to it indicates the actual number of cases. Excluded were all cases with more than one operation. To interpret these schemes correctly it should be borne in mind that adhesions were present also in patients without prior surgery (about 28 per cent). The localization of these nonsurgical adhesions is shown in Figure 10. Therefore, in Figures 5 to 9, the surgical adhesions are superimposed upon a certain number that are nonsurgical. This explains, for instance, the presence of adhesions between the omentum and gallbladder after appendectomy. (Figure 5.)

The Constitutional Factor. In comparing the average height and weight of men and women with and without adhesions (either spontaneous or postoperative) it appears that (1) height alone plays no role and (2) women in whom adhesions develop are heavier, whereas for men weight makes no significant difference. (Table III.)

In studying the height and weight of the non-surgical patients it appears that among women, whatever their height, those who have spontaneous adhesions are heavier. For men there is no significant difference. (Table IV.)

The situation is somewhat different in the post-operative cases; men and women who are at least 5

cm shorter than average and have adhesions are heavier than those without adhesions. This tendency is even greater in women. (Table V.)

Histopathology. We found foreign bodies in thirty-eight of the fifty-five postoperative adhesions (69 per cent) studied histologically. Some had given rise to granulomas with or without giant cells; in some cases the reaction was limited to enlarged histiocytes (epithelioid cells). All foreign bodies were located at or near a level corresponding to the former peritoneal surfaces. Under polarized light they could be classified as: (1) fine needles of talcum powder in twenty-six cases; in half of these, surgery had been carried out prior to 1955; in eight the history could not be found, but surgery was very likely in the distant past; (2) filaments of dressings, sutures, and so forth in seven cases; and (3) foreign bodies not otherwise identifiable in five cases.

Adhesions less than three months old showed, as expected, more cells, small inflammatory foci, and traces of blood in the form of iron (nine of eighteen cases). In one case we found a very early adhesion consisting of a blood clot in an eighty-five year old woman who had undergone cholecystectomy seventeen days before death. The omen-

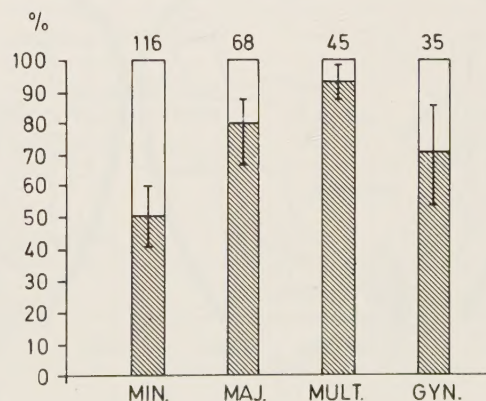
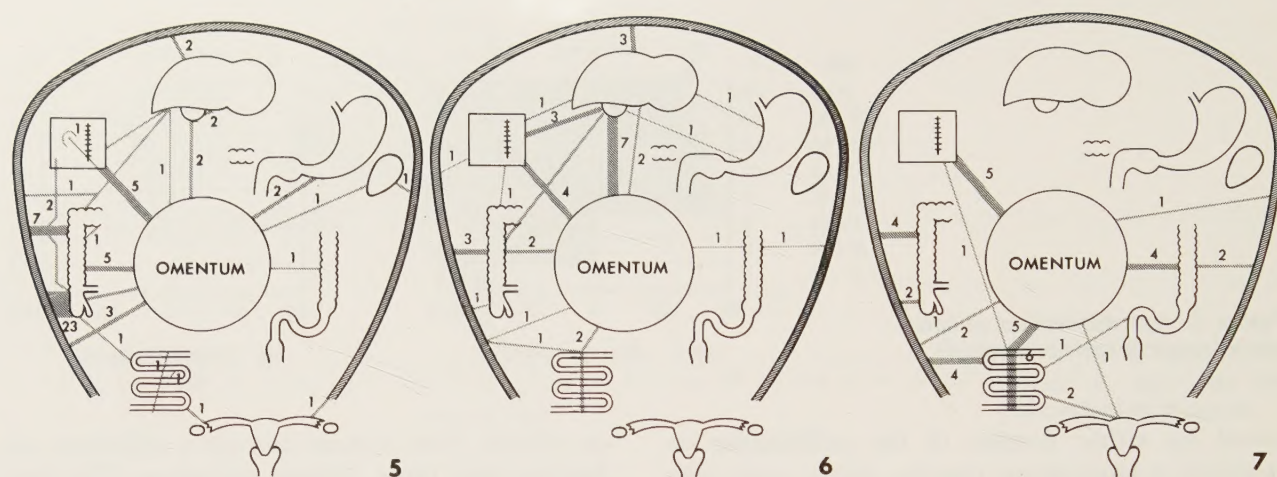


Figure 4. Relation between incidence of adhesions and type of surgery.



Figures 5, 6, and 7. Topography of adhesions after appendectomy in forty cases (Figure 5), after gallbladder surgery in nine cases (Figure 6), and after operations on the colon in twelve cases (Figure 7).

tum was attached to the parietal peritoneum near the laparotomy wound by a short brownish band; histologically the band was a blood clot, colonized on its surface by a single layer of cells of mesothelial aspect; at either end of the adhesion there was the beginning of organization by granulation tissue (there were no foreign bodies).

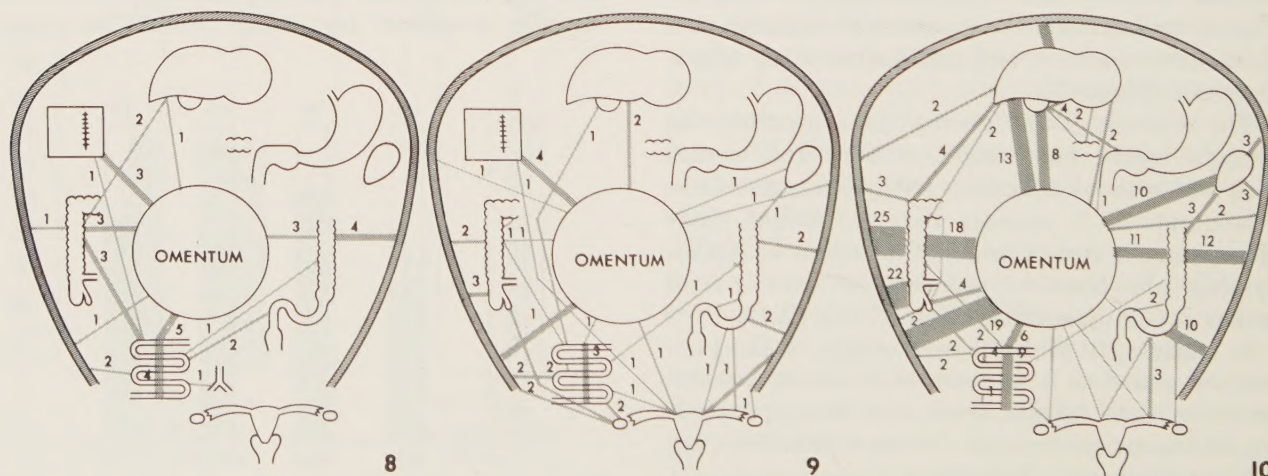
Comments

The classic pathogenesis of serosal adhesions need not be described; a fibrinous exudate fails to be dissolved by enzymes of leukocytic or peritoneal origin [17,22-24] and becomes organized into a collagenous adhesion [17,22]. A large number of agents may cause adhesions of this kind [10,11,15,25]. A second mechanism has been demonstrated in recent experimental studies; it requires two steps: a serosal injury, which may be minimal (such as mild drying), and then hemor-

rhage, which will cause blood to clot on the injured area and form the adhesion [26]. Such adhesions are formed by blood clots rather than by fibrinous exudate; an early example of this kind was found in our series.

Incidence of Adhesions. In a total of 752 autopsies we found 335 adhesions, that is, 44.45 per cent (45.2 per cent not counting the tumor cases). Our figure is somewhat higher than that found by Diebold [6] in 1930, of 31.1 per cent in 700 autopsies. It is possible that the difference reflects a lower incidence of surgery among persons who died in 1930 compared to those who died in 1970. In 1963 Benzer, Blümel, and Piza [7] found adhesions in 44.9 per cent of 303 autopsies. (See also [2].)

Spontaneous Adhesions. Of our cases, 454 had not undergone abdominal surgery, and yet 28 per cent of these had adhesions. This implies that in



Figures 8, 9, and 10. Topography of adhesions after operations on the aorta and iliac arteries in nine cases (Figure 8), after gynecologic operations in twenty-five cases (Figure 9), and spontaneous adhesions in 126 cases (Figure 10).

one of every four "normal" persons the development of abdominal adhesions is probable.

Diebold [6] and Benzer, Blümel, and Piza [7] made similar observations. Some of these spontaneous adhesions are surely congenital, but most are probably secondary to foci of inflammation (cholecystitis, appendicitis, diverticulitis, and so on) [1,8]. Therefore, among the 268 cases with prior surgery, a certain percentage of the adhesions were not caused by the surgery. This is especially obvious in patients who had undergone minor operations that left no adhesions around the site of operation, but in whom adhesions were found in an unrelated area. These "idiopathic" adhesions are never in the form of cords and rarely cause obstruction.

Role of Age. After the age of sixty spontaneous adhesions become significantly more frequent. This should not be surprising in view of the suggested pathogenesis: the longer a person lives, the greater are his chances for the development of an intra-abdominal infection [6]. Conversely, age does not seem to affect the incidence of postoperative adhesions; young and old seem to have the same chances.

Role of Sex. Figure 2 shows that women have about 4 per cent more adhesions than men. This is true for postoperative adhesions (68.6 versus 64.9 per cent) as well as for spontaneous adhesions (30.6 versus 25.9 per cent). This confirms the observations of Diebold [6]. Although the difference is not statistically significant, we believe that it is real and related to the function of the female genital organs (especially rupture of ovarian follicles with ensuing hemorrhage). It will be shown subsequently that sex also plays a role with respect to the "constitutional factor."

Topography of Adhesions. Figures 5 to 9 show that postoperative adhesions concentrate around the site of operation; some of those that form at a distance must be considered to be the "spontaneous" variety. In summing up all the locations in the ninety-five cases represented in these figures, it appears that the omentum is involved more than any other organ (ninety-two times), followed

by the large intestine (seventy-two), the small intestine (forty-seven), and the liver, spleen, and female genital organs (together twenty-one). Figure 10 summarizes the locations of the spontaneous adhesions (126 cases); the corresponding figures are 100, 88, 22, and 19. In this type, too, the omentum is involved most often. The reason for its frequent involvement is surely related to its structure, which is that of a net (mostly at the microscopic level); its meshes become easily entangled with the fibrin of both inflammatory exudates and clots [26]. Conversely, it appears that the small intestine forms few spontaneous adhesions (22 of 126 compared with 47 of 95 in postoperative cases); this probably means that it is especially susceptible to operative trauma, but rarely subject to nonsurgical inflammation [11,15,24,27-29].

Turunen [3], a gynecologist, showed similar results; in 271 cases of adhesions after gynecologic laparotomy, the omentum was involved in 56.8 per cent, the small intestine in 20.7 per cent, the colon in 18.8 per cent, and the rectum in 3.7 per cent; in contrast, of 73 cases of adhesions after appendectomy, the omentum was involved in 45.2 per cent, the colon in 46.6 per cent, the small intestine in 5.5 per cent, and the right tube and ovary in 2.7 per cent.

Constitutional Factor. Our data show that: (a) a thin woman, whatever her height, is considerably less susceptible to the development of spontaneous adhesions compared with a heavy woman; (b) for a man, the chances of spontaneous adhesions developing are the same, whatever his height and weight; (c) for a heavy woman, the chances of postoperative adhesions developing are greater if she is relatively short; if she is of average height or

TABLE I Spontaneous Adhesions: Significance of Age-Related Changes

Age Groups Compared	χ^2	P
11 to 40 versus 41 to 60	0.1726	<0.70
41 to 60 versus 61 to 80	9.9420	<0.005
61 to 80 versus >80	2.2627	<0.20

TABLE II Data on Forty-two Cases of Adhesions after Multiple Operations

	Number of Cases with <i>n</i> Operations					Types of Operations			
	<i>n</i> = 2	<i>n</i> = 3	<i>n</i> = 4	<i>n</i> = 5	Total	Minor	Major	Gynecologic	Total
Men	11	6	2	0	19	14	34	...	48
Women	14	6	2	1	23	23	28	8	59
Total	25	12	4	1	42	37	62	8	107

TABLE III Relation between Height, Weight, and Adhesions (Postoperative and Spontaneous)

	Average Height (cm)	Average Weight (kg)
Men		
With adhesions	175.56	66.42
Without adhesions	175.02	66.11
Total	175.23	66.22
T test	Not significant	Not significant
Women		
With adhesions	165.26	60.47
Without adhesions	164.79	57.79
Total	165.00	58.67
T test	Not significant	P < 0.05

taller, the chances are no greater than those in a thin woman; (d) for a man, this finding with regard to postoperative adhesions is similar but less pronounced (in fact, statistically significant only for the whole group).

We have no explanation for the first two findings and can only comment that large amounts of fatty tissue make the surgical procedure more difficult, longer, and more traumatizing, especially if the patient is relatively short. Our data contradict the current theory that "asthenic" patients are more prone to the development of adhesions [1,2,6,8,9], whereas they agree with the data of Turunen [3]; of 232 women who underwent repeated laparotomy, those who were relatively thin had fewer adhesions.

Role of Ascites. Several authors have suggested that ascites prevents the formation of adhesions, and therefore have introduced into the peritoneal cavity either Rheomacrodex® [20,29-33] or polyvinylpyrrolidone [34]. Our data cannot confirm this point of view. In our series of 752 autopsies, ascites was found in 83 cases. These cases were

distributed as follows: among 416 cases without adhesions, 44 had ascites (10.6 per cent); among 336 cases with adhesions, 39 had ascites (11.6 per cent). Ascites as such, therefore, does not prevent the formation of adhesions; if the authors mentioned previously had any success, this was more likely due to an effect of Rheomacrodex on clotting or to its "siliconizing" property [31].

Pathogenesis of Postoperative Adhesions. Foreign bodies were present in two thirds of the cases examined; in two thirds of this group the foreign body was talcum powder. Surely not all foreign body granulomas, some of which may be of microscopic size, produce adhesions, but the presence of foreign bodies in such a large proportion of adhesions is highly suggestive [14,25,35-42]. It goes without saying that these foreign bodies are introduced by the surgeon; after use, over 20 per cent of surgical gloves are found to be torn or pierced (results of twenty months' study on 35,763 gloves) [36], and the absorbable starch powders now used as lubricating agents can also cause adhesions [41].

Traces of blood (as iron) were present in nine of eighteen cases in which the histochemical reaction for iron was applied. The adhesions in this group were less than three months old. The presence of iron suggests that they had developed from a blood clot [11,38,43,44]; this emphasizes once again the importance of the hemorrhage in the pathogenesis of postoperative adhesions, as discussed previously [29].

Traces of other lesions were not found. This is not surprising; lesions such as those caused by drying [8,11,26,27,43,45], ischemia [46-48], or infection [11,27,48] or mechanical and thermic lesions [11,22,45,48,49] play a major role only in the initial phase of the formation of the adhesion by

TABLE IV Constitutional Factor in Spontaneous Adhesions (without Prior Surgery)

Height (cm)	With Adhesions		Without Adhesions		T Test
	Number of Cases	Weight (kg)	Number of Cases	Weight (kg)	
Men					
<171	18	59.50	60	59.05	Not significant
171 to 180	36	68.61	93	67.72	Not significant
>180	15	73.87	41	77.83*	Not significant
Women					
<161	17	63.53	46	50.20	P < 0.0025
161 to 170	30	62.20	57	56.39	P < 0.025
>170	5	82.80	27	68.22	P < 0.0125

* In this group, five men weighed over 100 kg; without these five the average was 73.3 kg.

causing the blood to clot or by inducing a fibrous exudate; thereafter the lesion heals, but the fibrous adhesion remains.

Suggested Preventive Measures. Our data suggest that all foreign bodies (not just talcum powder) are dangerous, even microscopic ones [38]. Gauze pads were surely the source of many of the microscopic foreign bodies that we observed. It should be noted that the various suture materials (catgut, silk, and nonabsorbable synthetic fibers) are about equal in their capacity to induce adhesions [50,51]. The corresponding preventive measures are obvious.

The recently demonstrated mechanism of adhesion formation, "coagulation over an injured surface," implies that great care should be exerted to avoid the combination of injury and bleeding (and especially that of drying of the serosa and bleeding); either injury or bleeding alone is less dangerous [11,26,27,41-43,50].

As to covering with peritoneum, it has been shown that if an area has been denuded of its peritoneal lining, it is better not to make any effort to cover it [15,38,42,48,51,53-57]. In areas in which adhesions are inevitable (such as over intestinal anastomoses or over the bare area left after cholecystectomy), it is better to cover with omentum, thereby creating "harmless" adhesions [58,59].

Recently, a number of chemical preventive measures have been suggested; from the vast amount of literature on the subject we have selected the following as most promising. (For an extensive review see Ellis [58].)

Association of heparin and trypsin: These two compounds have been combined by Aulusia, Gazzaniga, and Beretta [22] to form a complex called Tripsepar®, which actively dissolves fibrin,

has no affinity for fibrin inhibitors, is stable in the presence of antitrypsin, and does not alter prothrombin time. Furthermore, its trypsin component activates plasminogen. In several small series of rabbits the authors have obtained a decrease or even total inhibition of adhesion formation. A further point of interest is that intravascular thrombi can also be dissolved. However, further studies are needed.

Protoporphyrin: This has been used with considerable success in rats and mice [48,60]. Its mode of action is said to be twofold, that is, activation of the fibrinolytic system and an antianoxic effect at the cellular level.

Oxyphenbutazone (Tandearil®): This has been used with success in monkeys in a dosage of 10 mg/kg/day [61]. The alleged mechanisms of action are a decrease of the local inflammatory reaction and a possible blockage of the plasmin inhibitors (plasmin dissolves the fibrin mesh).

Streptokinase: This agent, highly purified and injected intraperitoneally, was suggested by Ellis [58] and by others [13,62-67]. It should be noted that this kinase activates only the plasminogen of man and rabbit, not that of the rat [13,64,66]. Two authors, using fairly large series of experimental animals (rats, dogs, and rabbits), were unable to confirm its effectiveness [68,69].

Glucocorticoids: Cortisone [38,70,71], hydrocortisone [14,39,72,73], and prednisolone butylacetate [74] have often been tried. They have been very effective, but have produced the well known secondary effects of delayed wound healing [39,70,74] and spread of infection [73,74]. Replogle, Johnson, and Gross [17] may have solved the problem by a special mode of administration; they suggest giving a high dose of dexamethasone over a short period of time together with an antihis-

TABLE V Constitutional Factor in Postoperative Adhesions (after Abdominal Surgery)

Height (cm)	With Adhesions		Without Adhesions		T Test
	Number of Cases	Weight (kg)	Number of Cases	Weight (kg)	
Men*					
<171	23	61.26	11	55.00	P < 0.10
171 to 180	42	66.07	20	60.60	P < 0.15
>180	19	71.89	9	72.55	Not significant
Women					
<161	18	56.72	11	45.72	P < 0.005
161 to 170	49	59.31	13	60.00	Not significant
>170	22	66.27	11	65.54	Not significant

* For men as a group, the t test was significant (P < 0.05).

tamine (promethazine) which contributes a decrease in the fibrinous exudate [75]. The data of Horne and Scott [21] tend to support these results; in 207 women who had undergone operative correction of sterility, there were fifty pregnancies in only three years. It may be possible to inhibit the effects of corticosteroids on wound healing with cartilage extracts [76–78].

Summary

In 752 consecutive autopsies, peritoneal adhesions were studied with regard to incidence, distribution, and pathogenesis. Adhesions were found in 67 per cent of the subjects who had undergone laparotomy and in 28 per cent of those who had not (the latter adhesions, called “spontaneous,” were presumably caused by foci of inflammation). The incidence of adhesions after minor, major, and multiple operations was 51, 72, and 93 per cent, respectively. Their topographic distribution, summarized in a scheme for each type of operation, points out the importance of surgical trauma as a causative factor. Histologic study confirmed the importance of microscopic foreign bodies (not only talcum powder, but also fluff from gauze pads and so forth) as well as the role of another recently described mechanism, coagulation of blood on an injured peritoneal surface. As regards constitutional factors, short women who were also obese were especially prone to postoperative adhesions; in men this tendency was less marked. Spontaneous adhesions were more frequent in heavy women; in men there was no difference. Age did not affect the incidence of postoperative adhesions, but there was an increase of spontaneous adhesions after the age of sixty. Sex played a role in that women had 4 per cent more adhesions. Ascites had no inhibiting effect. Preventive measures are briefly reviewed.

References

1. Payr E: Nachtrag zum Bericht über die Naturforscherversammlung. *Zentralbl Chir* 41: 99, 1914.
2. Burger K: Ueber peritoneale Verwachsungen. *Geburtshilfe Frauenheilkd* 3: 103, 1941.
3. Turunen AOI: Ueber die postoperativen Verwachsungen und deren Verhütung speziell im Anschluss an Gynäkologische Laparotomien. *Duodecim Ser B* 18: 1, 1933.
4. Swolin K: Experimentelle Studien zur Prophylaxe von intraabdominalen Verwachsungen. *Acta Obstet Gynecol Scand* 45: 473, 1966.
5. Naegeli T: Bauchfellverwachsungen: Untersuchung mittels Pneumoperitoneum. *Dtsch Z Chir* 163: 408, 1921.
6. Diebold O: Ueber Bauchfellverwachsungen: Leichenbefunde bei 700 Sektionen. *Arch Klin Chir* 158: 737, 1930.
7. Benzer H, Blümel G, Piza F: Ueber Zusammenhänge zwischen Fibrinolyse und intraperitonealen Adhäsionen. *Wien Klin Wochenschr* 75: 881, 1963.
8. Kaufman E: Ueber Bauchfellverwachsungen. *Bruns Beitr Klin Chir* 161: 599, 1935.
9. Payr E: Biologisches zur Entstehung, Rückbildung und Vorbeuge von Bauchfellverwachsungen. *Zentralbl Chir* 51: 718, 1924.
10. Boys F: The prophylaxis of peritoneal adhesions: a review of the literature. *Surgery* 11: 118, 1942.
11. Richardson EH: Studies on peritoneal adhesions. *Ann Surg* 54: 758, 1911.
12. Chandy J: Use of heparin in prevention of peritoneal adhesions. *Arch Surg* 60: 1151, 1950.
13. Gustavsson E, Blomback B, Blomback M, Wallen P: Plasmin in the prevention of adhesions. *Acta Chir Scand* 109: 327, 1955.
14. Luttwak EM, Behar AJ, Saltz NJ: Effect of fibrinolytic agents and corticosteroid hormones on peritoneal adhesions. *Arch Surg* 75: 96, 1957.
15. Connolly JE, Smith JW: The prevention and treatment of intestinal adhesions. *Int Abstr Surg* 110: 417, 1960.
16. Ellis H, Harrison W, Hugh TB: The healing of peritoneum under normal and pathological conditions. *Br J Surg* 52: 471, 1965.
17. Replogle RL, Johnson R, Gross RE: Prevention of post-operative intestinal adhesions with combined promethazine and dexamethasone therapy: experimental and clinical studies. *Ann Surg* 163: 580, 1966.
18. Eskeland G: Regeneration of parietal peritoneum in rats: 1. A light microscopical study. *Acta Pathol Microbiol Scand (A)* 68: 355, 1966.
19. Eskeland G, Kjaerheim Å: Regeneration of parietal peritoneum in rats: 2. An electron microscopical study. *Acta Pathol Microbiol Scand (A)* 68: 379, 1966.
20. Arquint A: Beitrag zur Verhütung von Adhäsionen im Bauchraum. *Helv Chir Acta* 3: 368, 1968.
21. Horne HW, Scott JM: Prevention of postoperative pelvic adhesions after conservative surgery. *Fertil Steril* 20: 1020, 1969.
22. Aulusia B, Gazzaniga M, Beretta T: The effect of a fibrinolytic substance in the prevention and treatment of post-operative peritoneal adhesions. *Panminerva Med* 8: 432, 1966.
23. Myhre-Jensen O, Larsen SB, Astrup T: Fibrinolytic activity in serosal and synovial membranes. *Arch Pathol* 88: 623, 1969.
24. Pugatch EMJ, Foster EA, Macfarlane DE, Poole JCF: The extraction and separation of activators and inhibitors of fibrinolysis from bovine endothelium and mesothelium. *Br J Haematol* 18: 669, 1970.
25. Myllärniemi H: Foreign material in adhesion formation after abdominal surgery: a clinical and experimental study. *Acta Chir Scand Suppl* 377, 1967.
26. Ryan GB, Grobety J, Majno G: Postoperative peritoneal adhesions: a study of the mechanisms. *Am J Pathol* 65: 117, 1971.
27. Walthard M: Zur Aetiologie peritonealer Adhäsionen nach Laparotomien und deren Verhütung. *Corresp Schweiz Az* 15: 513, 1893.
28. Jackson BB: Observations on intraperitoneal adhesions, an experimental study. *Surgery* 44: 507, 1958.
29. Kern E: Adhäsionsprophylaxe im Bauchraum mit makromolekularen Substanzen. *Helv Chir Acta* 33: 305, 1966.
30. Polishuk WZ, Aboulafia Y: Dextran in prevention of peritoneal adhesions. *Isr J Med Sci* 3: 806, 1967.
31. Kapur BML, Gulati SM, Talwar JR: Prevention of peritoneal adhesions by low molecular dextran in the monkey. *Indian J Med Res* 56: 1406, 1968.
32. Razdan JL, Sushil S, Srimannarayana A: Postoperative

- intra-peritoneal adhesions. *J Indian Med Assoc* 57: 275, 1971.
33. Aszondi A, Chaimoff C, Dintzman M: Rheomacrodex in the prevention of intraperitoneal adhesions. *Int Surg* 57: 559, 1972.
 34. Mazufi MK, Kalambaheti K, Pawar B: Prevention of adhesions with polyvinylpyrrolidone. *Arch Surg* 89: 1011, 1964.
 35. German WK: Dusting powder granulomas following surgery. *Surg Gynecol Obstet* 76: 501, 1943.
 36. Seelig MG, Verda DJ, Kidd FH: The talcum powder problem in surgery and its solution. *JAMA* 123: 950, 1943.
 37. Eiseman B, Seelig MG, Womack NA: Talcum powder granuloma: a frequent and serious postoperative complication. *Ann Surg* 126: 820, 1947.
 38. Nicol M: Recherches expérimentales sur les adhérences péritonéales post-opératoires et leur prévention par la cortisone. *Mém Acad Chir (Par)* 78: 793, 1952.
 39. Zachariae L: Hydrocortisone acetate applied intraperitoneally I. Inhibitory effect on adhesions produced by talc. *Acta Endocrinol (Kbh)* 16: 149, 1954.
 40. Saxén L, Myllärniemi H: Foreign material and postoperative adhesions. *N Engl J Med* 279: 200, 1962.
 41. Myllärniemi H, Frilander M, Turunen M, Saxén L: The effect of glove powders and their constituents on adhesion and granulomaformation in the abdominal cavity of the rabbit. *Acta Chir Scand* 131: 312, 1966.
 42. Schade DS, Williamson JR: The pathogenesis of peritoneal adhesions: an ultrastructural study. *Ann Surg* 167: 500, 1968.
 43. Baisch K: Klinische und experimentelle Untersuchungen über postoperativen Ileus. *Beitr Geburtshilfe Gynaekol* 9: 437, 1905.
 44. Gueullette R: Les brides intrapéritonéales "en corde." *Mém Acad Chir (Par)* 72: 71, 1946.
 45. Lehman EP, Boys F: The prevention of peritoneal adhesions with heparin, an experimental study. *Ann Surg* 111: 427, 1940.
 46. Ellis H: The aetiology of post-operative abdominal adhesions, an experimental study. *Br J Surg* 50: 10, 1963.
 47. Myllärniemi H, Karppinen V: Vascular pattern of peritoneal adhesions. *Br J Surg* 35: 605, 1968.
 48. Iijima N, Yamamoto T, Inoue K, Gomi F: Experimental studies on intra-abdominal adhesions. *Postgrad Med J* 46: 278, 1970.
 49. Jentzer A, Calame A: Contribution à l'étude de la Sulfanilamidothérapie par voie intra-péritonéale et par voie rectale. *Schweiz Med Wochenschr* 19: 601, 1943.
 50. Hubbard TB, Khan MZ, Carag VR, Albites VE, Hricko GM: The pathology of peritoneal repair: its relation to the formation of adhesions. *Ann Surg* 165: 908, 1967.
 51. Storey BG, Lawrenson KB, Chant S, Stephens FO: Factors influencing the incidence of postoperative abdominal adhesions: an experimental study. *Aust NZ J Surg* 40: 388, 1971.
 52. Werthemann A: Die Pathologie der abdominellen Verwachsungen. *Helv Chir Acta* 33: 235, 1966.
 53. Franz K: Ueber die Bedeutung der Brandschorfe in der Bauchhöhle. *Z Geburtshilfe Gynaekol* 47: 64, 1902.
 54. Robbins GF, Brunschwig A, Foot FW: Deperitonealization: clinical and experimental observations. *Ann Surg* 130: 466, 1949.
 55. Thomas JW, Rhoads JE: Adhesions resulting from removal of serosa from an area of bowel. *Arch Surg* 61: 565, 1950.
 56. Williams DC: The peritoneum. A plea for a change in attitude towards this membrane. *Br J Surg* 42: 401, 1955.
 57. Conolly WB, Stephens FO: Factors influencing the incidence of intraperitoneal adhesions: an experimental study. *Surgery* 63: 976, 1968.
 58. Ellis H: The cause and prevention of postoperative intraperitoneal adhesions. *Surg Gynecol Obstet* 133: 497, 1971.
 59. Vance JFA, Williams HTG: Mechanical support of healing small intestinal anastomoses by adhesions. *Can J Surg* 15: 101, 1972.
 60. Iijima N, Yamamoto T, Inoue K: Prevention of intra-abdominal adhesions by protoporphyrin, an experimental study. *Jap J Exp Med* 39: 311, 1969.
 61. Kapur ML, Talwar JR, Gulati SM: Oxyphenbutazone—anti-inflammatory agent in prevention of peritoneal adhesions. *Arch Surg* 98: 301, 1969.
 62. Wright LT, Smith DH, Rothman M, Quash ET, Metzger WI: Prevention of postoperative adhesions in rabbits with streptococcal metabolites. *Proc Soc Exp Biol Med* 75: 602, 1950.
 63. Spagna PM, Peskin GW: An experimental study of fibrinolysis in the prophylaxis of peritoneal adhesions. *Surg Gynecol Obstet* 113: 547, 1961.
 64. Villavicencio JL, Gross RE: Critical thrombolytic dosages of human fibrinolysin in the treatment of peritoneal adhesions. An experimental study. *Surg Forum* 13: 348, 1962.
 65. Close AS, Redfern WT, Polacek M, Balcos EG: Effect of intra-peritoneal fibrinolysin on reformation of intestinal adhesions. *JAMA* 183: 543, 1963.
 66. James DCO, Ellis H, Hugh TB: The effect of streptokinase on experimental intraperitoneal adhesion formation. *J Pathol* 90: 279, 1965.
 67. Benzer H, Blümel G, Piza F: Zusammenhänge zwischen intraperitonealen Adhäsionen und Fibrinolyse. *Klin Med (Wien)* 19: 137, 1964.
 68. Collins DI, Sandy JT: Peritoneal adhesions: experimental use of fibrinolysin to prevent reformation. *Arch Surg* 91: 413, 1965.
 69. Jewett TC, Ambrus JL, Ambrus CM, Mink IB: Effects of fibrinolytic enzymes on experimentally induced peritoneal adhesions. *Surgery* 57: 280, 1965.
 70. Hubay CA, Weckesser EC, Holden WD: The effect of cortisone on the prevention of peritoneal adhesions. *Surg Gynecol Obstet* 96: 65, 1953.
 71. Scantis AL, Schatten WE, Weckesser EC: Effect of hydrocortisone in the prevention of intraperitoneal adhesions. *Arch Surg* 71: 523, 1955.
 72. Zachariae L: Hydrocortisone acetate applied intraperitoneally. II. Inhibitory effect on adhesions produced by serosal injury. III. Inhibitory effect on re-formation of surgically separated adhesions. *Acta Endocrinol (Kbh)* 19: 269, 1955.
 73. Zachariae L: Hydrocortisone acetate applied intraperitoneally. IV. Effect in the presence of infection. V. Effect after establishing intestinal anastomoses. *Acta Endocrinol (Kbh)* 19: 275, 1955.
 74. Eskeland G: Prevention of experimental peritoneal adhesions in the rat by intraperitoneally administered corticosteroids. *Acta Chir Scand* 125: 91, 1963.
 75. Jacquemain RJ, Shumacker HB: Effect of Histadyl upon the prevention of peritoneal adhesions. *Am J Surg* 104: 20, 1962.
 76. Lattes R, Martin JR, Meyer K, Ragan C: Effect of cartilage and other tissue suspensions on reparative processes of cortisone-treated animals. *Am J Pathol* 22: 979, 1956.
 77. Pappas AM, Evans VJ, Hyatt GW, Earle WR: Acceleration of skin defect closure. *Surg Gynecol Obstet* 113: 681, 1961.
 78. Prudden JF, Gabriel O, Allen B: The acceleration of wound healing. *Arch Surg* 86: 171, 1963.

